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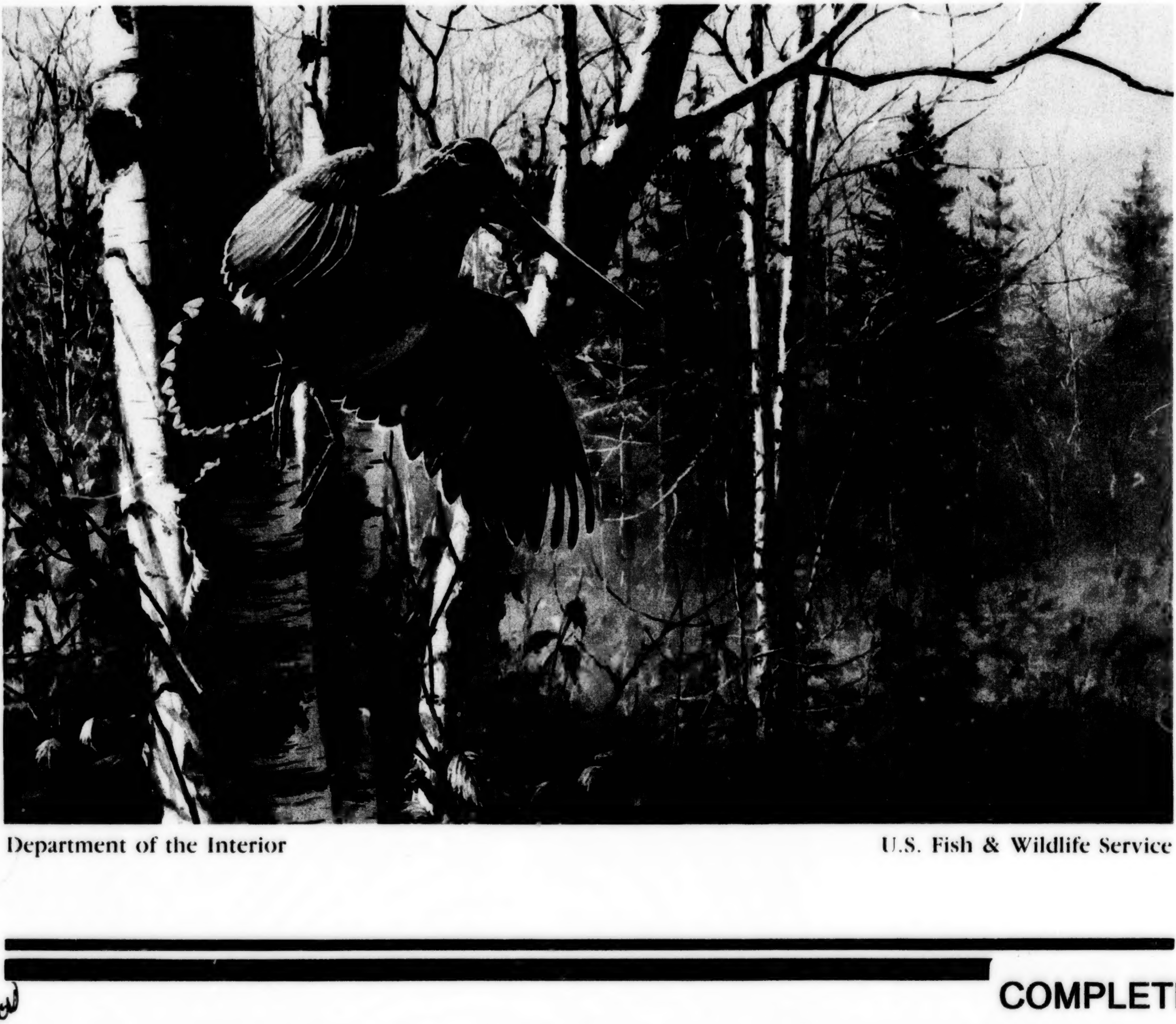
American Woodcock

Harvest and Breeding Population Status, 1991



Department of the Interior

U.S. Fish & Wildlife Service

COMPLETED

AMERICAN WOODCOCK HARVEST AND BREEDING POPULATION STATUS, 1991

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Abstract: Wing-collection and Singing-ground Surveys were conducted to determine the population status of American Woodcock. Age ratio information from harvested woodcock indicated that the recruitment index (ratio of immatures per adult female) varied between 1989 and 1990. In the U. S. portion of the Eastern Region, productivity increased substantially from 1.4 to 1.8 (+28.9%) immatures per adult female. In the U. S. portion of the Central Region, the productivity index showed little change, increasing from 1.6 to 1.7 (+1.9%) immatures per adult female. Between 1989 and 1990, there were no changes in Federal frameworks for woodcock hunting regulations; however, indices of hunting success (average daily and seasonal bags) declined in both the Eastern and Central Regions. Eastern Regional daily success declined from 2.0 in 1989 to 1.8 woodcock bagged per day in 1990 (-5.5%), while the seasonal success index declined from 9.3 to 7.7 woodcock bagged per season (-17.9%). In the Central Region the daily success index decreased from 2.5 birds per day in 1989 to 2.4 birds per day in 1990 (-2.2%), while the seasonal success index decreased from 12.9 to 12.2 woodcock bagged per season (-5.4%). Analysis of Singing-ground Survey data using route regression methodologies indicated a non-significant increase of 5.1% between 1990 and 1991 and a significant ($P<0.05$) long-term (1968-91) decline of -1.6% per year in the Eastern Region. Route regression results for the Central Region breeding population showed a non-significant 3.7% increase between 1990 and 1991 and a non-significant long-term decline of 0.8% per year. Comparison of recent (1985-91) versus historical trends (1968-84) in the Singing-ground Survey revealed that the rate of decline between these periods was significantly different for both regions. Breeding indices in both regions have been increasing at rates of 0.6% per year since 1985. The trends for 1985-91 are not significantly different from zero but suggest that woodcock populations may be stabilizing in both regions.

The American woodcock (*Scolopax minor*) is a popular game bird throughout eastern North America, providing an estimated 3.4 million person-days of recreational hunting annually (U.S.D.I. 1989). As stated in the recently released "American Woodcock Management Plan," the management objective of the U.S. Fish and Wildlife Service (FWS) is to increase population levels of woodcock to levels consistent with the demands of consumptive and non-consumptive users. To meet this objective, and to conform with the requirements of the Migratory Bird Treaty Act, the FWS in cooperation with the Canadian Wildlife Service (CWS) and 39 state and provincial fish and wildlife agencies conducts two annual surveys of woodcock populations — the *Wing-collection Survey*, and the *Singing-ground Survey*. These surveys allow biologists to monitor the status of woodcock populations and aid wildlife administrators in setting harvest regulations.

The *Wing-collection Survey* is a cooperative effort between woodcock hunters, FWS, and state wildlife agencies. Each fall, a sample of hunters submit one wing from each woodcock they bag to FWS and provide supplemental information on their hunting success rates. The data collected in this survey provide information on woodcock productivity during the previous spring as measured by the relative

The primary purpose of this report is to facilitate the prompt distribution of timely information. Results are preliminary and may change with the inclusion of additional data.

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abundance of juvenile woodcock in the bag. This survey also provides an index to hunter success rates during the previous hunting season.

The *Singing-ground Survey* provides an index to the current year's breeding population. This survey is conducted by hundreds of government employees and volunteers from the United States and Canada. Because the routes were randomly located and are run each year, the survey provides an index to the total breeding population in the surveyed area. Accordingly, this survey reflects trends in both the total amount of available woodcock habitat and the relative abundance of birds in that habitat.

Although the Wing-collection Survey and the Singing-ground Survey are imperfect in several respects, they provide the best information on woodcock population status currently available. The FWS is investigating improved methodologies in an effort to provide better information to biologists and administrators in the future.

METHODS

Reliable annual estimates of population size, productivity, harvest size and distribution are fundamental to comprehensive woodcock management. Unfortunately, this information is difficult and often impractical to obtain. Woodcock are difficult to find and count because of their cryptic coloration, small size, and preference for densely vegetated habitat. Also, no comprehensive sampling frame for woodcock hunters exists. Because of these difficulties, the Wing-collection Survey and Singing-ground Survey were developed to provide indices of populations, productivity and harvest levels.

Woodcock Management Units

Woodcock breed throughout most of eastern North America (Owen 1978). However, woodcock biologists have traditionally recognized two relatively discrete populations, as defined by Glasgow (1958), Martin et al. (1969), and Krohn et al. (1974) (Fig. 1). Because detailed analyses of band recovery data support the existence of these populations as relatively discrete units (Coon et al. 1977), Eastern and Central Regions were designated for administrative purposes. Accordingly, the results of the Wing-collection Survey and Singing-ground Survey are reported separately for each management unit.

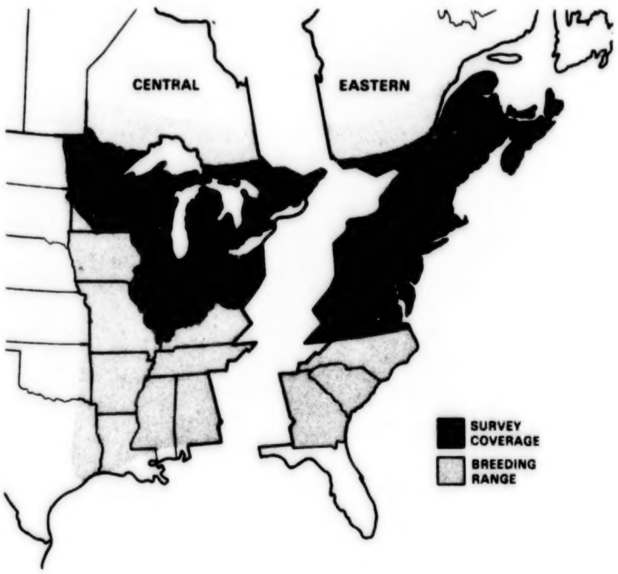

Fig. 1. Woodcock management regions, breeding range, and Singing-ground Survey coverage.

Wing-collection Survey

The Wing-collection Survey was developed in the early 1960's to monitor the productivity of woodcock. In the absence of a method for selecting woodcock hunters at random, woodcock hunters were solicited from state fish and game agencies and from duck stamp purchasers who indicated that they also hunt woodcock. Survey participants also included hunters who: (1) participated in the previous year's survey; (2) requested that they be included in the survey; or (3) indicated on a state or Federal harvest survey that they hunted woodcock in the previous hunting season.

Wing-collection Survey participants were provided with prepaid mailing envelopes and asked to submit one wing from each woodcock they bagged. In addition, the hunters were asked to record the effort and success of their hunts.

Age and sex ratios in the harvest were determined by examining plumage characteristics (Martin 1964) during the annual FWS "wingbee" (a cooperative work session). The ratio of immature birds per adult female provided an index to production during the 1990 breeding season. Indices of hunting success were measured by daily and seasonal bag. The indices of recruitment and hunter success were calculated based on data from successful hunters who participated in both 1989 and 1990, in order to maintain comparability between years. Both recruitment and hunter success were weighted to compensate for differences in the proportion of the estimated woodcock harvest attributable to each state and adjusted to a base year value for comparison with previous years. Further information on survey procedures can be found in Clark (1970, 1972, 1973).

Singing-ground Survey

The Singing-ground Survey was developed to exploit the conspicuous courtship display of the male woodcock. Early studies demonstrated that counts of singing males provide indices to woodcock populations and can be used to monitor annual changes (Mendall and Aldous 1943, Goudy 1960, Duke 1966, and Whitcomb 1974). Before 1968, counts were conducted on non-randomly located routes. Beginning in 1968, routes were relocated by placing them in the center of randomly chosen 10-minute blocks within each state and province in the middle and northern portions of the woodcock's breeding range (Fig. 1).

The current survey consists of approximately 1,500 routes. The routes are located on lightly traveled secondary roads and consist of 3.6-mile long segments with 10 listening stops. The routes were surveyed shortly after sunset by driving to each of the 10 stops. At each stop, the observer recorded the number of woodcock heard "peenting". The survey dates coincide with peaks in courtship behavior of resident woodcock. In most states, the actual peak of singing activity may occur earlier in the spring and in some situations, local reproduction may be underway. This compromise is necessary to avoid counting migrating woodcock.

In order to avoid adverse weather conditions which might affect singing behavior or listening conditions, surveys were only conducted when wind, rain, and temperature conditions are acceptable.

Approximately one half of the 1,500 Singing-ground Survey routes are run each year. However, in order to avoid expending unnecessary manpower and funds, the balance of these routes are carried as "constant zeros." Routes for which no woodcock are heard for at least two consecutive years enter this constant zero status and are run once every 5 years until woodcock are heard. Once woodcock are heard, the route enters a normal status and is again run each year. Data from constant zero routes were included in the analysis only for the years they were actually surveyed. Sauer and Bortner (1991) review the implementation and analysis of the Woodcock Singing-ground Survey in more detail.

Route Regression Methodology. -- Trends were estimated for each route by fitting a line using linear regression of the natural logarithm of the original counts + 0.5 (Geissler 1984) versus year. Observer data were used as covariables in the regression to adjust for differences in observers' ability to hear woodcock. To estimate state and regional trends, the slope estimates of the individual routes were back-transformed and weighted average slopes were calculated for the areas of interest as described by Geissler (1984). The weighting factors used for estimates of state and provincial trends were the mean number of woodcock heard on each route and a measure of the relative consistency with which those routes were surveyed over time. Regional estimates were further weighted by state and provincial land areas. Variances associated with the state, provincial, and regional slope estimates were estimated using a bootstrap procedure (Efron 1982). The weighted geographic slope estimates were expressed as percent change per year. Trend significance was assessed using Z based confidence intervals with $P<0.10$.

Route regression analyses cannot use routes on which no birds were heard during the interval of interest; hence, sample sizes (number of routes) may be smaller than the actual number of routes run in a state or province. Also, routes for which data were received after May 31, 1991 were not included in the current analysis but will be included in future long-term trend estimates.

Annual Indices Estimation. -- Annual indices were calculated for regions by finding the deviation between the observed count on each route and that predicted by the regional trend estimate. These residuals were averaged by year and added to the fitted trend to produce annual indices of abundance for each region. Therefore, yearly variation in woodcock abundance is superimposed on the long-term fitted trend. The advantage of this method is that the indices provide a realistic representation of annual variation about a fitted trend. In order to estimate the percent change from 1990 to 1991, a short-term trend (2 years) is calculated. The percent change estimated from this short-term trend analysis is the best estimator of annual change. Comparisons of the breeding population indices (which are derived from residuals of the long-term trends) will yield less precise results.

Recent vs. Historical Trends. -- Annual indices reported in Bortner (1990) appeared to indicate that recent trends in the breeding population indices were different from historical trends. In order to test this hypothesis, recent trends in the Singing-ground Survey (1985-91) were compared to historical trends (1968-84) through the use of Z test on the difference between those trends ($P<0.10$). The choice of a changepoint for this analysis was somewhat arbitrary, but 1985 was chosen because significant regulatory changes occurred in the Eastern Region in that year. This is not to imply that any relationship between woodcock population trends and the effects of harvest regulations can be inferred from the results of this analysis

RESULTS

Wing-collection Survey

Approximately 5,004 potential woodcock hunters were contacted and asked to participate in the 1990-91 Wing-collection Survey. Thirty-four percent (1903 hunters) (Table 1) cooperated by submitting 9,141 wings (Table 2) and supplemental information on 3,548 hunts (Table 3). Northern hunters submitted more wings than southern hunters, leading to an unbalanced geographic distribution in the wing sample.

Recruitment. -- The ratio of immature woodcock to adult females in the harvest provides an index of recruitment to the population during the previous breeding season. In the United States' portion of the Eastern Region the recruitment index increased from 1.4 to 1.8 (+28.9%) immatures per adult female between 1989 and 1990 (Table 2). Meanwhile, the recruitment index in the

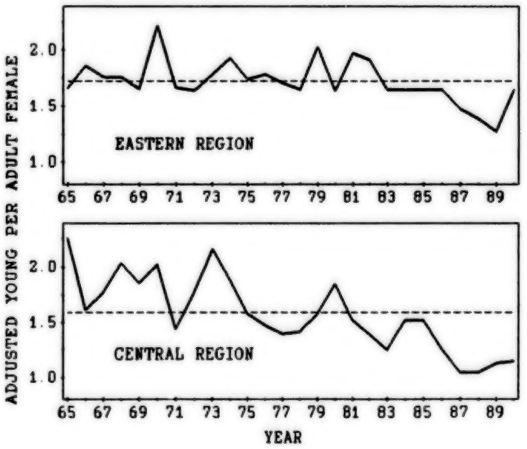

Figure 2. Base year adjusted indices of recruitment, 1965-1990. Base year is 1969. Dashed line is the average long-term base year value.

United States' portion of the Central Region increased from 1.6 to 1.7 (+1.9%) immatures per adult female.

The 1990 recruitment indices were adjusted to a base year value for comparison with previous years (Fig. 2). The increase in the Eastern Region recruitment index brought the base year value close to the long-term average. The base year value for the Central Region remains below the long-term average.

Hunting Success. -- There were no changes in 1990-91 Federal frameworks for woodcock hunting. However, indices of daily and seasonal hunting success decreased in both regions.

The 1990 indices of daily and seasonal success were adjusted to base year values for comparison with previous years (Figs. 3 and 4). The current base year values of daily and seasonal hunting success remain below long-term averages in both regions.

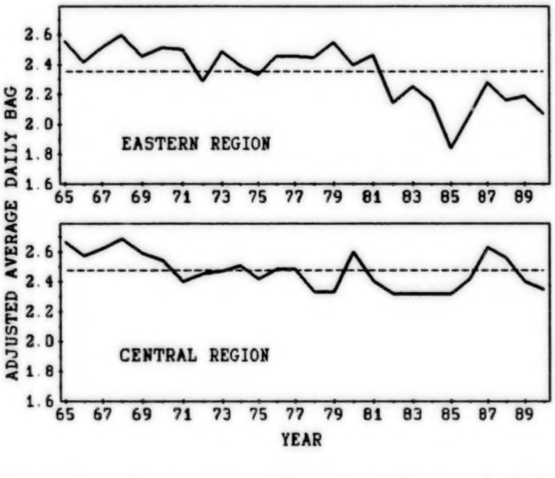

Figure 3. Base year adjusted indices of daily hunting success, 1965-90. Base year is 1969. Dashed line is the average long-term base year value.

Singing-ground Survey

Route Regression. -- Short-term (1990-91) trend analysis showed significant ($P<0.10$) increases in number of woodcock heard per comparable route in Connecticut, Maine, Nova Scotia and Vermont. However, no significant change was noted for either the Eastern or Central Region (Table 4 and Figure 5).

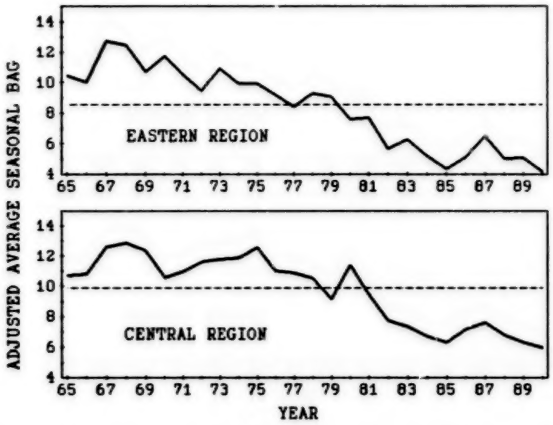

Figure 4. Base year adjusted indices of seasonal hunting success, 1965-90. Base year is 1969. Dashed line is the average long-term base year value.

Long-term (1968-91) trends were computed from 654 routes in the Eastern Region and 648 routes in the Central Region. In the Eastern Region, significant ($P<0.10$) long-term declining trends were noted for Connecticut, Maine, Maryland, New Brunswick, New Jersey, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia and the entire region (Table 4). The long-term trend for the Eastern Region indicates a mean annual decrease of 1.6% per year ($P<0.01$) (Table 4 and Figure 6).

In the Central Region, significant ($P<0.10$) long-term declining trends were noted for Indiana, Ohio, and Wisconsin. The trend for the Central Region was a non-significant decline of -0.8% per year.

Annual Breeding Population Indices. -- The 1990 Eastern Region breeding population index of 2.09 singing males per route is slightly above the predicted index of 2.00 singing males per route (Figure 7). The Central Region population index of 2.67 males per route is slightly above the predicted index of 2.53 males per route (Fig. 7).

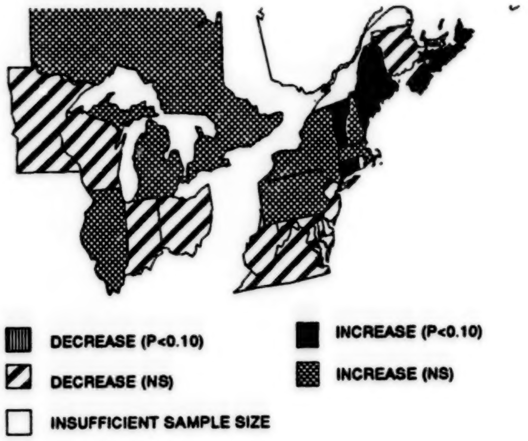

Figure 5. Short-term trends in number of American woodcock heard on the Singing-ground Survey; 1990-91.

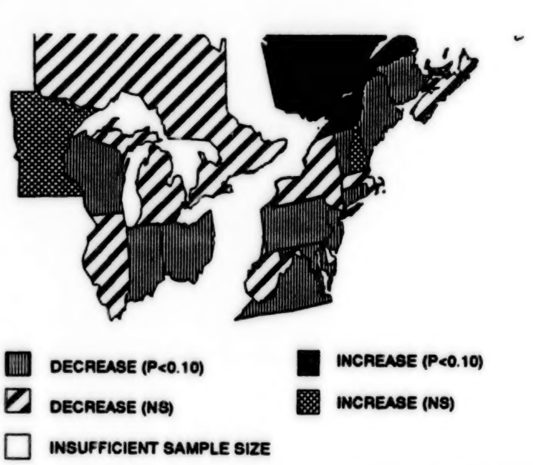

Figure 6. Long-term trends in number of American woodcock heard on the Singing-ground Survey; 1968-91.

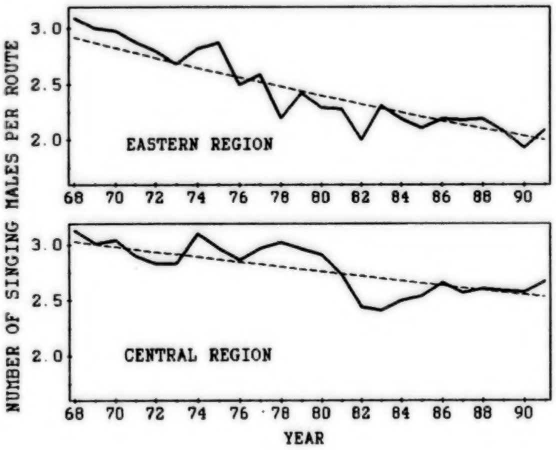

Figure 7. Long-term trends and annual indices of number of woodcock heard on woodcock Singing-ground Survey, 1968-91.

Recent vs. Historical Trends. -- The Eastern and Central Region breeding population trends for 1985-91 are not significantly different from zero ($P>0.10$). However, the slopes from 1985-91 were positive (+0.6%) and significantly different than slopes from 1968-84 for both the Eastern and Central Regions ($P<0.10$). Individual states/provinces showing differences between these time periods were New Brunswick, New Jersey, New York, Massachusetts, Vermont, and Michigan. All of those slope changes were in a positive direction with the exception of New Jersey. In the Eastern Region since 1985, Connecticut, Maryland, and New Jersey have shown significantly decreasing trends while New Brunswick has shown an increasing trend. In the Central Region, Illinois shows a significant negative trend since 1985 (Table 4).

DISCUSSION

Wing-collection Survey

The cause of the long-term decline in the Central Region recruitment index is not known. Preliminary investigations indicate the cause may be an artifact of the base year procedure and the weighting method as age ratio trends which are not base year adjusted appear to be stable (Bortner 1990). FWS intends to investigate alternative methods of analysis for these data in the near future.

Hunting success indices should be interpreted cautiously in light of the potential biases associated with the non-random sampling procedure which is used to select survey participants. Although unquantified, these biases may have serious effects on the results of this survey. A comprehensive critique of these problems is beyond the scope of this report, so readers are directed to Owen (1978). Development of a statistically valid sampling frame is vital to improving this aspect of woodcock management.

Singing-ground Survey

Possible explanations for the increase in woodcock heard in Connecticut, Maine, Nova

Scotia, and Vermont during 1991 are: (1) increased singing activity due to the mild spring temperatures which were experienced this year; (2) mild winter weather in 1990-91 which may have resulted in increased over-winter survival; (3) increased recruitment in the New England states during 1990 as suggested by the Wing-collection Survey.

The apparent stabilization of breeding population trends in both regions during the past 7 years is encouraging but it should be noted that several states (Connecticut, Maryland, New Jersey, and Illinois) have declined significantly during this period, while only New Brunswick has increased. The long-term trends for many states and provinces show significant negative declines. Based on these long-term trends, concern for the welfare of the American woodcock is justified. Maintaining and creating woodcock habitat is critical if further population declines of woodcock are to be avoided.

ACKNOWLEDGEMENTS

Personnel from the U.S. Fish and Wildlife Service, Canadian Wildlife Service, and the many state and provincial agencies and some private individuals assisted in collecting the Singing-ground Survey data and processing wings at the Wing-collection "wingbee." The 1991 "wingbee" was hosted by the Minnesota Cooperative Fish and Wildlife Research Unit. Special appreciation is extended to D. Anderson and L. Kuester who coordinated this work session. Individuals who helped with the wingbee were: M. Olinde (Louisiana Dept. of Wildl. and Fish.); D. Dessecker (The Ruffed Grouse Society); T. Engel (Minnesota DNR); L. Greg (Wisconsin DNR); J. Arnold, P. Caldwell, M. deRosier, B. Gentry, D. Herr, G. Sepik, W. Stancill, and P. Yakupzack (U. S. FWS); and S. Miller. Many woodcock hunters cooperated by sending in wings and supplemental hunting information. J. R. Sauer developed the method for calculating annual indices, refined the route regression programs for analysis of the Singing-ground Survey data, and provided general statistical guidance. L. Whitman and F. Hicks provided computer programming and computer processing support. Data entry was ably conducted by the Electronic Data Processing Section of the Office of Migratory Bird Management. I express particular recognition to M. A. McKeogh, who provided valuable assistance in conducting both surveys, processing data forms, and provided secretarial support. P. Keywood prepared the figures. J. B. Bortner and J. R. Sauer reviewed the manuscript and provided helpful comments. Special thanks are due the regional, state, and provincial Singing-ground Survey coordinators. Portions of this report were copied in whole or in part from previous status reports.

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Table 1. Distribution of hunters contacted and response rates in 1990-91 woodcock wing collection survey.

State of residence	Number of contacts by Code					Total Contacts	No. of Cooperators	Percent Cooperating
	1	2	4	6	9			
AL	2	8	1	4		15	2	13
AK	1	2		1		4	1	25
AR	8	8		4		20	5	25
CA	1	2		1		4		0
CO		2				2		0
CT	61	74	4	26		165	64	39
DE	3	9		4		16	4	25
DC	1	1				2	1	50
FL	4	10		5		19	3	16
GA	10	30		7		47	8	17
IL	16	61	3	13		93	22	24
IN	43	54	4	14		115	38	33
IA	20	45	4	7		76	16	21
KS	8	10		2		20	7	35
KY	12	20	1	5		38	12	32
LA	104	117	3	34		258	80	31
ME	90	91	4	37		222	84	38
MD	11	37	1	6		55	13	24
MA	99	122	10	36		267	111	42
MI	328	445	27	76		876	376	43
MN	160	279	19	40		498	162	33
MS	1	15		4		20	2	10
MO	23	52		13		88	24	27
MT	2	1				3	2	67
NE	2	6		3		11	3	27
NH	55	45	10	20		130	60	46
NJ	44	53	2	13		112	42	38
NY	167	231	5	33		436	153	35
NC	16	42	2	11		71	15	21
ND	1	3				4	2	50
OH	61	124	6	21		212	80	38
OK	8	14		3		25	5	20
PA	114	290	3	38		445	128	29
RI	11	6	1	7		25	13	52
SC	10	35	1	7		53	9	17
SD	0	3				3		0
TN	13	16	2	3		34	12	35
TX	6	24		7		37	5	14
UT	1	1				2	1	50
VT	66	31	2	15		114	44	39
VA	33	36		27		96	30	31
WA		1				1		0
WV	11	5	3	1		20	12	60
WI	175	538	6	66		785	252	32
WY		1				1		0
Total	1802	3000	124	614	0	5540	1903	34

Code 1 - Previous year's Code 1, 2, 4, and 9 hunters who submitted wings.
Code 2 - Waterfowl harvest survey hunters who reported hunting woodcock.
Code 4 - Requested participation or proposed by fellow hunter.
Code 6 - Previous year's Code 1 who did not submit wings.
Code 9 - From list provided by state, primarily from state harvest survey.

Table 2. Comparison of woodcock recruitment indices for 1989 and 1990 by state and region. Woodcock recruitment indices were calculated as the number of immatures per adult female harvested by cooperators who participated in both years. State and regional indices were calculated for states represented by at least 125 wings. Regional indices were weighted by the estimated woodcock harvest in those states.

State of harvest	Number of wings recieved		Adult females		Immatures		Immatures per adult female	
	1989	1990	1989	1990	1989	1990	1989	1990
Eastern Region								
CT	110	118	25	25	70	83	a	a
FL	0	0	0	0	0	0	a	a
GA	10	44	5	13	4	13	a	a
ME	730	559	210	148	329	290	1.6	2.0
MD	9	19	4	3	4	12	a	a
MA	180	157	48	45	82	87	1.7	1.9
NH	449	361	157	106	195	180	1.2	1.7
NJ	155	150	31	36	96	71	3.1	2.0
NY	770	629	286	185	312	309	1.1	1.7
NC	49	41	17	11	27	18	a	a
PA	308	336	93	85	131	169	1.4	2.0
RI	9	39	1	11	6	19	a	a
SC	7	20	2	5	4	10	a	a
VT	532	306	187	91	199	140	1.1	1.5
VA	78	84	16	19	48	40	a	a
WV	40	42	12	9	16	22	a	a
Region	3436	2905	1094	792	1523	1463	1.4	1.8
Percent change								28.9%
Central Region								
AL	2	0	0	0	2	0	a	a
AR	16	2	6	0	5	2	a	a
IL	15	22	1	4	7	15	a	a
IN	204	154	39	35	123	84	3.2	2.4
IA	23	20	8	7	11	9	a	a
KS	3	0	1	0	1	0	a	a
KY	18	11	4	4	10	4	a	a
LA	909	976	199	183	561	657	2.8	3.6
MI	2849	2598	849	877	1392	1152	1.6	1.3
MN	1053	933	398	391	391	351	1.0	0.9
MS	2	1	1	0	1	0	a	a
MO	66	53	12	10	35	19	a	a
NE	0	1	0	0	0	0	a	a
OH	345	355	119	109	147	175	1.2	1.6
OK	10	14	0	1	5	6	a	a
TN	29	32	9	4	15	17	a	a
TX	17	10	1	2	11	4	a	a
WI	1041	1054	374	305	403	514	1.1	1.7
Region	6602	6236	2021	1932	3120	3009	1.6	1.7
Percent change								1.9%

[a] Number of wings recieved was less than 125.

Table 3. Comparison of state and regional indices to daily and seasonal woodcock hunting success. State and regional indices are calculated for states represented by at least 10 hunters who participated in both years. Regional indices were weighted by the estimated woodcock harvest in those states.

State of residence	Number of hunters	Number of hunts		Woodcock bagged		Average bag per hunt		Average bag per season	
		1989	1990	1989	1990	1989	1990	1989	1990
Eastern Region									
CT	19	60	58	100	109	1.7	1.9	5.3	5.7
FL	0					a	a	a	a
GA	2	7	19	10	44	a	a	a	a
ME	42	259	194	517	371	2.0	1.9	12.3	8.8
MD	3	5	8	8	15	a	a	a	a
MA	26	96	82	150	118	1.6	1.4	5.8	4.5
NH	30	147	135	318	253	2.2	1.9	10.6	8.4
NJ	17	76	73	148	140	1.9	1.9	8.7	8.2
NY	71	340	298	664	527	2.0	1.8	9.4	7.4
NC	8	28	22	48	37	a	a	a	a
PA	40	140	155	268	308	1.9	2.0	6.7	7.7
RI	3	6	14	9	27	a	a	a	a
SC	3	6	6	7	11	a	a	a	a
VT	30	204	126	405	223	2.0	1.8	13.5	7.4
VA	12	35	46	74	79	2.1	1.7	6.2	6.6
WV	4	15	15	27	27	a	a	a	a
Region	310	1424	1251	2753	2289	2.0	1.8	9.3	7.7
Percent change							-5.5%		-17.9%
Central Region									
AL	0					a	a	a	a
AR	2	7	2	8	2	a	a	a	a
IL	2	7	11	13	18	a	a	a	a
IN	12	77	67	176	149	2.3	2.2	14.7	12.4
IA	3	12	12	22	19	a	a	a	a
KY	3	10	8	15	9	a	a	a	a
LA	52	278	317	839	916	3.0	2.9	16.1	17.6
MI	197	1105	980	2551	2252	2.3	2.3	12.9	11.4
MN	72	411	366	983	881	2.4	2.4	13.7	12.2
MS	1	2	1	2	1	a	a	a	a
MO	10	23	30	61	52	2.7	1.7	6.1	5.2
OH	25	122	130	335	352	2.7	2.7	13.4	14.1
OK	2	5	3	8	4	a	a	a	a
TN	8	17	16	29	32	a	a	a	a
TX	3	9	6	16	10	a	a	a	a
WI	74	333	341	841	868	2.5	2.5	11.4	11.7
Region	466	2418	2290	5899	5565	2.5	2.4	12.9	12.2
Percent change							-2.2%		-5.4%

[a] Number of participating hunters was less than 10.

Table 4. Trends (% change per year[a]) in number of American woodcock heard in the Singing-ground Survey as determined by the route regression technique.

State, Province, or Region	2-year trend (1990-91)			7-year (1985-91)		24-year (1968-91)	
	# routes[b]	N[c]	%change	N	% change	N	%change
Eastern Region							
CT	4	2	43.2 *[d]	4	-10.9 ***	10	-7.5 **
DE	2	0	--	0	--	0	--
ME	49	36	19.0 *	55	-2.2	63	-2.0 **
MD	9	3	-11.3	9	-9.6 *	24	-6.9 ***
MA	16	13	1.7	14	-4.6	20	-4.4
NB	44	21	-6.6	51	3.6 *	64	-1.8 *
NH	11	7	27.3	15	1.0	18	0.2
NJ	10	5	-30.3	11	-18.5 ***	17	-8.1 ***
NY	65	48	3.6	73	1.8	105	-0.8
NS	22	19	33.3 *	36	1.1	52	-1.6
PA	31	18	1.8	28	-5.1	67	-4.4 ***
PEI	10	6	7.8	10	-3.1	13	1.2
QUE		0	--	16	14.8	57	3.2 **
RI	1	0	--	0	--	3	-7.7 ***
VA	25	6	-19.1	23	-3.9	70	-7.1 ***
VT	18	12	22.1 **	17	5.0	22	-2.5 *
WV	31	12	-21.8	26	-6.0	49	-1.4
Region	348	208	5.104	388	0.632	654	-1.625 ***
Central Region							
IL	17	10	42.9	16	-22.0 ***	39	-1.3
IN	20	7	-14.4	17	8.0	49	-4.0 *
MI	116	87	9.7	128	1.7	139	-0.5
MN	70	53	-0.7	78	2.0	108	0.7
OH	37	24	-20.2	34	-4.1	70	-4.5 **
ON	86	58	6.9	118	-1.0	134	-0.3
WI	80	57	-2.7	86	-0.2	109	-1.6 **
Region	426	296	3.749	477	0.645	648	-0.769
Continent	774	504	4.072	865	0.632	1302	-1.058 **

[a] Mean of weighted route trends within each State, Province, or Region. To estimate the total percent change over several years, use: $100(\%/100+1)^y-100$ where % is the annual change and y is the number of years.

[b] Total number of routes which were run and recieved prior to 5/31/91.

[c] Number of routes comparable in at least two years with one or more counts greater than zero.

[d] Indicates slope is significantly different from zero: * $P<0.10$, ** $P<0.05$, *** $P<0.01$.

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Table 5. Breeding population indices for American woodcock from Woodcock Singing-ground Survey, 1968-1991. Annual indices are calculated as the predicted value from the trend analysis plus the difference between the observed value and predicted value for each year.

State, Province, or Region	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Eastern Region													
CT	a	3.66	3.54	2.93	3.72	2.78	2.78	2.98	1.64	1.76	1.16	1.18	1.04
ME	4.69	4.71	5.09	4.61	4.45	4.66	4.67	4.97	4.31	3.98	3.63	3.96	3.54
MD	3.00	2.93	2.65	2.49	2.11	2.37	2.09	2.02	1.44	1.50	1.65	1.36	1.46
MA	a	3.11	3.59	4.21	3.03	4.06	3.16	1.93	2.58	1.95	2.46	2.52	1.79
NB	a	5.56	5.84	5.30	5.65	4.79	5.37	6.33	4.67	5.37	3.98	4.40	4.00
NH	a	3.12	3.60	2.91	3.62	2.81	3.84	3.25	3.93	3.48	3.40	3.39	3.83
NJ	3.71	2.72	4.21	5.13	3.30	4.70	4.57	3.44	1.89	2.07	1.42	2.47	1.50
NY	3.69	4.06	3.09	3.53	3.41	3.44	3.66	3.19	3.24	3.37	2.71	3.12	3.62
NS	3.74	2.68	2.29	2.77	2.39	2.53	2.92	2.74	2.40	2.29	2.54	2.14	1.96
PA	2.36	2.11	2.47	2.04	1.84	1.92	1.44	1.73	1.60	1.65	1.26	1.29	1.29
PEI	a	2.48	2.16	2.85	2.43	1.97	2.78	4.07	3.64	3.21	2.56	3.13	2.34
QUE	a	a	a	2.73	2.57	2.09	2.48	2.46	2.01	2.18	2.78	2.81	3.07
RI	a	0.87	1.03	1.62	1.39	1.39	1.04	0.80	0.80	a	0.27	0.46	0.46
VA	a	1.84	1.93	1.52	1.37	1.03	1.56	1.37	1.05	1.20	0.87	1.00	0.80
VT	a	2.56	4.34	3.23	3.73	3.13	3.07	3.64	3.26	3.80	2.71	2.70	2.42
WV	1.23	1.39	1.04	0.98	1.19	1.01	0.87	1.10	0.98	1.04	0.71	1.01	0.86
Region	3.09	3.00	2.98	2.88	2.80	2.68	2.82	2.87	2.50	2.59	2.20	2.42	2.29
Central Region													
IL	a	a	0.34	0.36	0.35	0.34	0.27	0.37	0.29	0.30	0.29	0.31	0.25
IN	1.67	1.25	1.17	0.94	1.19	1.24	0.96	0.96	0.97	0.97	0.80	1.08	0.81
MI	5.01	4.90	4.69	4.53	4.32	4.67	5.39	5.45	5.08	4.73	5.10	5.08	5.04
MN	a	3.26	2.78	3.26	2.78	3.07	3.88	3.47	3.33	3.37	3.49	3.51	3.74
OH	a	a	2.14	2.08	1.87	1.52	1.79	1.44	1.70	1.92	1.47	1.17	1.12
ON	5.12	5.73	5.39	5.30	5.56	5.06	5.62	5.16	4.77	5.58	5.96	5.74	6.11
WI	3.69	3.39	3.89	3.33	3.22	3.32	3.42	3.24	3.11	3.34	3.60	3.35	2.99
Region	3.13	3.01	3.04	2.90	2.83	2.83	3.10	2.97	2.86	2.97	3.02	2.96	2.91
Continent	3.08	2.99	2.99	2.88	2.81	2.75	2.95	2.92	2.68	2.78	2.58	2.69	2.59

[a] No routes surveyed or data not available as of 5/31/91.

Table 5. Continued.

State, Province, or Region	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Eastern Region											
CT	1.40	1.84	1.42	1.04	0.96	1.31	0.76	1.54	0.69	0.60	0.72
ME	3.89	2.70	3.48	3.45	3.42	3.66	3.98	3.71	3.64	2.67	3.13
MD	1.29	1.40	1.01	0.89	0.89	0.79	0.70	0.75	0.79	0.68	0.58
MA	1.82	1.55	1.18	2.00	1.60	1.67	1.72	1.71	1.33	1.28	1.43
NB	4.09	4.04	4.33	3.83	3.98	3.28	3.78	3.85	4.89	4.12	3.99
NH	4.30	2.50	2.92	2.59	2.75	4.66	3.31	3.32	3.23	2.96	3.64
NJ	1.25	1.43	1.35	1.49	1.15	1.20	1.30	1.01	1.01	0.59	0.59
NY	3.33	2.72	3.36	2.59	3.34	2.86	2.57	2.98	2.47	2.84	3.11
NS	1.82	1.55	1.98	2.00	1.91	2.27	2.14	2.11	2.09	1.65	2.37
PA	1.26	1.09	1.23	1.27	1.00	1.22	1.19	0.96	0.82	0.99	0.99
PEI	1.91	2.03	3.16	3.29	2.76	3.79	3.26	4.44	3.88	3.26	2.56
QUE	2.67	2.64	3.41	3.14	3.23	3.52	3.83	a	a	a	a
RI	0.27	1.12	0.64	0.67	0.22	0.22	a	0.32	0.32	a	0.22
VA	0.88	0.88	0.74	1.05	0.57	0.57	0.61	0.50	0.45	0.39	0.46
VT	2.16	1.59	2.37	2.35	1.75	2.24	2.34	2.54	2.39	2.37	2.41
WV	1.16	1.01	1.11	0.84	0.85	0.83	0.89	0.73	0.77	0.83	0.76
Region	2.28	2.00	2.31	2.19	2.11	2.19	2.18	2.19	2.08	1.93	2.09
Central Region											
IL	0.28	0.22	0.33	0.24	0.38	0.28	0.33	0.25	0.32	0.20	0.33
IN	0.86	0.64	0.67	0.66	0.56	0.75	0.69	0.52	0.59	0.65	0.59
MI	4.22	4.46	3.77	4.32	4.52	4.56	4.21	4.46	4.33	4.14	5.08
MN	3.55	3.32	3.03	2.73	3.19	3.47	3.34	3.65	3.42	3.70	3.55
OH	1.33	0.99	1.36	1.20	1.03	0.88	1.01	1.07	0.86	0.99	0.80
ON	5.86	4.45	4.58	4.86	4.94	5.06	4.99	4.81	5.31	5.22	5.17
WI	2.58	2.49	2.52	2.76	2.55	3.02	2.82	2.88	2.67	2.66	2.58
Region	2.73	2.44	2.41	2.50	2.54	2.66	2.57	2.61	2.59	2.58	2.67
Continent	2.51	2.23	2.36	2.36	2.34	2.44	2.39	2.42	2.36	2.27	2.41

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[a] No routes surveyed or data not available as of 5/31/91.

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